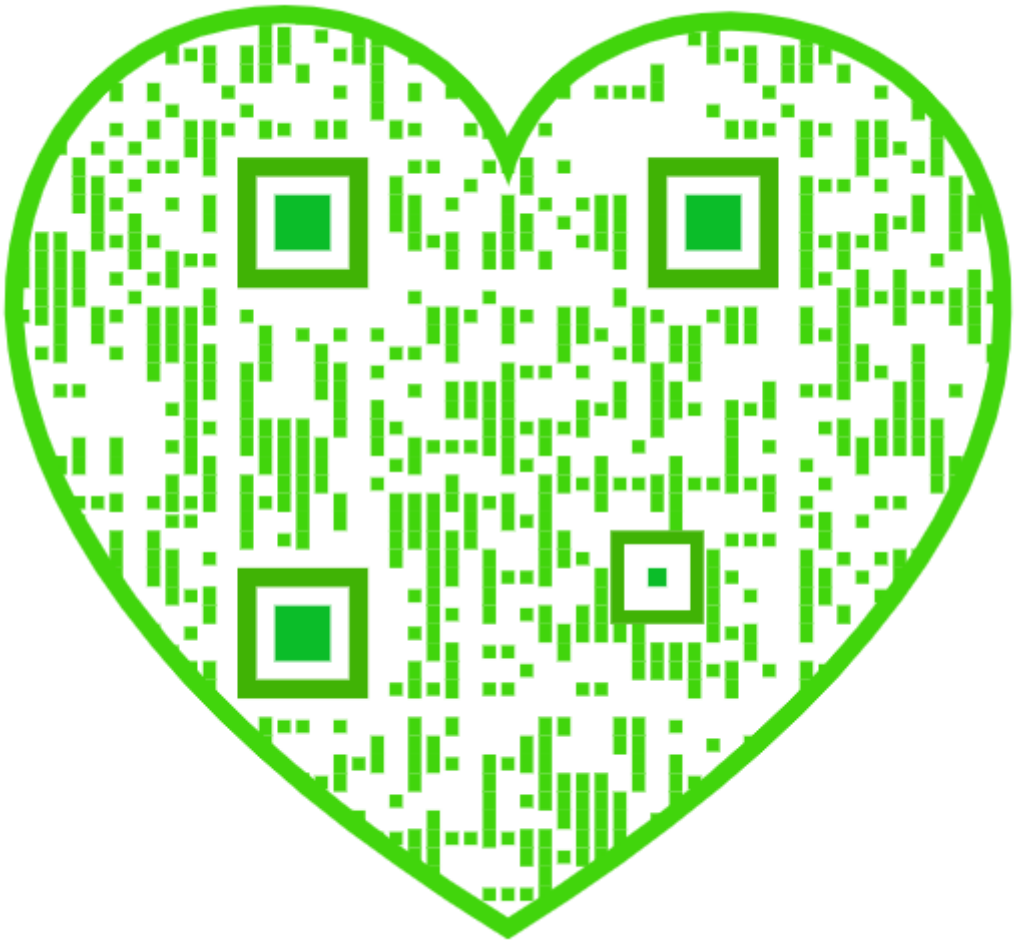

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COFFEE

BY

B. E. DAHLGREN

CHIEF CURATOR, DEPARTMENT OF BOTANY

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LEAFLET 22

FIELD MUSEUM OF NATURAL HISTORY

CHICAGO

1938

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COFFEE TREE IN FLOWER

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DEPARTMENT OF BOTANY
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COFFEE

ORIGIN AND HISTORY OF COFFEE DRINKING

The coffee tree is of African origin but makes its first appearance as a cultivated plant in the southwestern corner of the Arabian peninsula. The first positive account of it is found in an Arabic manuscript of the fifteenth century. It was then being grown in the mountains of Yemen on the eastern border of the Red Sea, probably having been introduced by Abyssinian invaders one or two hundred years before. The fact that coffee is not mentioned in the Koran supports the belief that its previous history in Arabia had been relatively short. It is thought to have come into common use there only in the fourteenth century.

In the absence of historical information Arabic legends attribute its introduction to various Musulman personages famous for their merits or for their devotions, such as the Sheikh Shadili of Mocha, the patron saint of Mohammedan coffee merchants, or the Mufty Gemaleddin, who, having seen coffee drunk in Persia, made use of it himself and introduced the custom in Aden.

A well-known story from Syria, many times retold, is of the monastery goatherd whose charges became lively to the point of refusing their customary siesta after browsing on the leaves and the fruit of a strange bush, and of the Mollah conceiving the idea of trying its effect on his monks who were given to somnolence at evening prayers.

The fact that the coffee tree grows wild in various parts of Africa, especially in the mountains of Southern Abyssinia, where it has undoubtedly been used since

ancient times and is now gathered for export from wild plants, was not discovered until the European exploration of Africa was begun. In the meantime coffee remained definitely associated only with Arabia. The Arabic name, like the Abyssinian, for the tree, *bun* or *el-bunn*, is applied also to the fruit and even to the coffee powder. The Arabic name for the brew is *kahwa*, from which come the word coffee and its variants in European languages. The scientific designation of the plant, *Coffea arabica*, was conferred upon it by Linnaeus in 1756. If its African origin had been known to the great classifier, he would probably have called it *abyssinica* or *ethiopica*.

The existence of various other species of coffee, growing wild in Africa, is of relatively recent discovery. Many of these have been tried in cultivation and a few of them are being grown on a large scale, but the so-called Arabian coffee remains by far the most important and most widely planted species.

The use of the dark brown brew as a social and ceremonial beverage apparently originated and developed in Arabia. At first the drink of the learned and religious only, it gradually came into general use. The manner of its preparation and serving there is described by Doughty in his *Arabia Secreta*.

"In every coffee sheykh's tent there is a new fire blown in the hearth, and he sets in his coffee pots; then snatching a coal in his fingers he will lay it in his tobacco-pipe. A few coffee beans received from his housewife are roasted and brayed; as all is boiling he sets out the little cups, *fenjeyl* (for fenjeyn) which we saw have been made, for the uningenious Arabs, in the West. The roasted beans are pounded amongst Arabs with a magnanimous rattle . . . and (as all their labour) rhythmical—in brass of the town, of an old wooden mortar, gayly studded with nails, the work of some nomad smith. The water bubbling in the small dellal, he cast in his fine coffee powder, *el-bunn*, and withdraws the pot to simmer a moment.

From the knot in his kerchief he takes then an head of cloves, a piece of cinnamon or other spice, *bahar*, and braying these, he casts their dust in after. Soon he pours some hot drops to essay his coffee; if the taste be to his liking, making dextrously a nest of all the cups in his hand, with pleasant clattering, he is ready to pour out for the company, and begins upon his right hand; and first, if such be present, to any considerable sheykh and principal persons.

"The fenjeyn *kahwa* is but four sips: to fill it up to a guest, as in the northern towns, were among Beduins an injury, and of such bitter meaning, "Drink thou and depart."

In the middle of the fifteenth century, coffeehouses were found in all important Arabian towns. With the caravan trade and the annual pilgrimages to Mecca, its use soon spread to the rest of the Mahommedan world, across the Persian Gulf and to northern India, and northward to Cairo, Egypt (1500), Syria, and to Stamboul (1554).

As popular gathering places where the idle could gossip and amuse themselves, where officials, officers, traders, merchants and navigators talked politics, the coffeehouses almost everywhere incurred the displeasure of the muftis and ulemans who saw their mosques empty, and often also of the civil authorities who scented potential danger in political discussions and possible intrigues. Coffee was praised by its friends for its excellent qualities. It would quicken the wit, restore the weary, comfort the body, enable the religious to spend the night in devotions, etc. It was condemned by its enemies as contrary to the teachings of the Koran, as being, if not wine, certainly charcoal, and equally objectionable. The coffeehouses were closed in Mecca in 1511, wrecked in Cairo in 1534, forbidden repeatedly in Constantinople.

In Persia, each coffeehouse was supplied with an official teacher and expounder of the law. The Sultan

Selim I, who greatly extended the Ottoman Empire, thereby furthering the spread of coffee, reversed the decree against it. He is said to have hanged two Persian doctors for maintaining it to be injurious to health, but his successors closed all coffeehouses in the Ottoman Empire and in 1633 coffee and tobacco were forbidden under pain of death. The use of both survived, however, the following thirty years of prohibition, and after 1663 coffeehouses were again permitted to operate in Turkey but were licensed. In Cairo there were then two thousand shops in which coffee was served.

Mocha was long the chief center of the coffee trade and for two hundred years Arabia retained a monopoly of the supply.

From Constantinople the use of coffee found its way to Italy early in the seventeenth century. It is said to have appeared in Venice in 1624 and the following year in Rome. A Venetian, Mocangi, "pevere," was the first European vender.

In France, Marseille was the first city to receive coffee in bales from Egypt and the first to have a coffeehouse. Pascal, an Armenian, opened the first *café* in Paris, where his master, the Turkish Ambassador, at his receptions had dispensed coffee Turkish style, intriguing the French aristocrats, more interested in the manner of its serving than in "the Turks berry drink." Pascal's attempt was not a great success, but more luxurious establishments came into existence, the most famous of them being "Café Procope," so named from its proprietor, and "Café de la Régence." The most illustrious literary and political characters of France were frequenters of one or other of these. "He imagines himself a person of importance because he goes every day to the Procope," wrote Voltaire of one of his contemporaries. He himself was a constant patron, as were Rousseau, Diderot, Marat, Robespierre, and Danton. Bonaparte is said to have been obliged to

leave his hat there for security, while he went in search of cash to pay his bill.

At the Café de la Régence, Voltaire appeared also and Diderot was to be seen working on his encyclopedia. Rousseau, Richelieu, Buffon, Alfred de Musset, Victor Hugo, and Théophile Gautier were among its frequenters.

Cafés multiplied, hundreds of less important ones were opened—all meeting places for the idle or those with some leisure for playing chess or cards, for discussion and oratory, and sometimes for dissension and intrigue. At the Café Foy began the harangue that initiated the siege of the Bastille.

It has been said that the whole of Paris, with eighteen hundred coffeehouses, became one vast café and the whole of France, the Café de l'Europe.

In England coffee is thought to have been sold first at Oxford in 1650 by Jacob, a Jew from Lebanon. A London merchant having brought coffee from Smyrna, and a Greek or Armenian servant who understood its roasting and preparation, opened a coffeehouse in 1652. Arthur Tilyard's coffeehouse at Oxford dating from 1655 became at once a center of intellectual life. Out of the informal meetings and discussions which took place among its frequenters grew the Royal Society. In London, coffeehouses soon became numerous and by 1675 they numbered three thousand. Every rank and profession, "every shade of religious and political opinions had its own headquarters," says Edward Forbes Robinson in his *Early History of Coffee Houses in England*. Charles II denounced them as "seminaries of sedition" and issued a proclamation against them which aroused so much protest that it was rescinded within a few days. Some of the more exclusive ones eventually developed into clubs. Lloyd's coffeehouse for wayfarers and traders, where maritime bulletins were posted for the benefit of customers, became the world-renowned underwriting establishment and

register of shipping which is still an important factor in England's navigation and trade.

Almost from the beginning of the introduction of coffee into Europe, Holland played an important part in its trade and cultivation. Dutch traders visited Aden in Arabia in 1614 and brought home the first samples of coffee. A commercial shipment from Mocha arrived in Amsterdam in 1640 and regular imports from Arabia were established 1660. The first coffeehouse is said to have been opened in Holland (1666) fifteen years later than in England, and in the nearby German free port of Hamburg in 1679. Coffee drinking was somewhat slow in becoming established in Germany, but it gradually spread there to such an extent that a hundred years after its first introduction, Frederick the Great is said to have exclaimed: "The increase in consumption of coffee is deplorable—almost every commoner and peasant has acquired the coffee habit. If that were restricted to some extent, the people would again resort to beer, and that would naturally benefit their own breweries. It would also prevent so much money, spent to purchase coffee, from going out of the country. Even His Royal Highness himself, in his younger days, was raised on beer-soup, besides, it is much better for their health than coffee."

In Austria the Turks, on abandoning the siege of Vienna in 1683, left behind a large supply of coffee to which they had set fire. The hero of the moment, a Pole who had been in Turkey and apparently was the only one who understood the nature of the smoke emanating from the sacks on fire, requested them as part of the reward for his services which saved the city and made use of the supply to open a coffeehouse, the first in Austria. Vienna coffeehouses became famous and remained distinguished for their high character. With daily papers and periodicals, native and foreign, supplied by the management and offering their patrons conveniences for correspondence,

BRAZILIAN COFFEE TREE IN FRUIT

JUSSIEU'S ILLUSTRATION OF A COFFEE BRANCH

they became an extremely important factor in the social and intellectual life of the town.

Coffee eventually reached Russia from Austria and from Constantinople, but owing to its high price it never attained as general use there as in other European countries. In the eighteenth century it finally reached the Scandinavian peninsula, where its present day household consumption is even greater than that of Holland.

A mortar for braying coffee came to New England in the *Mayflower*, being brought by the parents of Peregrine White. The Dutch brought coffee to New Amsterdam in 1668. William Penn bought his coffee in the New York market, paying 18 shillings six pence or $4.68 per pound. The first coffeehouse in Boston was opened in 1869, in New York in 1696. Being usually taverns, rather than cafés, the American coffeehouses never attained the popularity or social importance of those in Europe. On the other hand, coffee as a beverage for household use grew rapidly in favor.

THE ARABIAN COFFEE PLANT

CULTIVATION, HARVESTING, AND PREPARATION OF THE CROP

The Arabian coffee plant is a shrub or small tree of the Madder Family, *Rubiaceae*, with glossy, deep green, simple leaves, opposite in alternating pairs. Not being shed annually, the leaves are often said to be evergreen. As a matter of fact, they have been found to have a life of three to five years. The main branches are arranged in pairs at right angles to the straight, perpendicular stem, each pair of primary branches at right angles to the next. The secondary branches arising from them are seen to be given off at an acute angle and to assume their position in a horizontal plane. During the flowering periods, of which there are generally two each year, a principal one lasting two to three months and a secondary one, each ideally corresponding to a season of relatively little rainfall, the coffee trees become covered with delicate,

white flowers, giving off a jasmine-like odor. They are borne in the leaf-axils of the leaves the preceding year, in small clusters, each consisting of three to four umbels of a few flowers or buds. Details of the structure of the

Coffee flower and fruit (*Coffea arabica*) enlarged (x5). Half of the tubular corolla and of the ovary removed to show the pistil and the two ovules in the ovary which becomes the two-seeded coffee fruit. Below, fruit natural size in vertical section, and enlarged in transverse section to show relative position of seed, seedcoat, parchment and pulp.

flowers are to be seen in the adjoining illustration. Each flower lasts only a short time, at most two days, after which the tubular 5-parted corolla with the stamens is shed. The fruit develops rather slowly, the production of the ripe, two-seeded drupe, usually called a berry, requiring eight to nine months.

The ovary of the flower is two-celled, with one ovule in each cell. Each ovule normally develops into a so-called coffee "bean," a seed with a delicate membranous seed coat, the so-called silver skin of the coffee bean. As the fruit develops, the wall of the ovary enlarges greatly to form the pericarp of the drupe. At the time of maturity, this consists mostly of a fleshy and mucilaginous pulp (mesocarp), covered externally with a dark red "skin" or epiderm (epicarp). The internal wall of the ovary, i.e. that part of it lining the cells or cavities in which the seeds develop (endocarp), becomes quite hard and horny, like the seed-house in an apple, though somewhat firmer, forming the so-called parchment which, after the removal of the fleshy pulp, is seen to enclose each coffee bean. Within the parchment coat the seed is found to be covered by a thin membranous seed coat, the so-called silver skin, generally glistening and closely adherent to the green seed.

In English-speaking countries where coffee is produced, the fruit is often spoken of as a "cherry," and if a very tough and juiceless cherry had two large kernels or stones instead of one, well flattened against each other and parchment-like or horny in consistency instead of stony, it would be very similar to a coffee drupe.

After maturity, the coffee seed retains its vitality for about three months, and, if planted under suitable conditions, germinates in three weeks to a month. Seedlings grow rapidly, producing four or five pairs of leaves in as many months, and the first pair of lateral branches in eight to nine months.

A young Arabian coffee plant generally begins flowering in its third year, producing its first small crop in the fourth. Its maximum production is in most places reached in its seventh to tenth year, perhaps usually in the eighth, and it will continue to bear in somewhat diminishing ratio from the tenth up to twenty or thirty and even to fifty years and will sometimes live to be a hundred, though in most of the places where it is planted it is actually very

much shorter-lived. In Arabia, the coffee trees are said to mature in five years and to require replacement within twenty years from planting. In some central American plantations where severe pruning of the trees is practised, the number annually required for replacement is as high as ten per cent. On the average plantation it is much less. In Brazil it is said to be about 4 per hundred.

New plants are produced in various ways. The usual practice in most places is to plant selected seed in seed beds, transferring the seedlings, as soon as they have developed one or two pairs of leaves, to a nursery where they are set out, properly spaced, under some form of shade until they reach a size convenient for a second transplanting or final setting out when six to eight months old. In Brazil a common practice is to plant the seeds directly in the field where they are to remain, several seeds being dropped in each hole to produce a clump with three or four stems to grow up together.

The distance between plants varies from one and a half or two to three or four meters, and the number of plants per acre varies accordingly from 360 to 600 trees. The unit of area used on coffee plantations is generally the metric hectare, 1,000 square meters, equivalent to 2.35 acres. It is usually estimated that one workman is needed to care for each hectare or for each 1,000 trees, but many plantations manage with less.

The amount of pruning practised varies from almost none, except removal of suckers and of dead branches, as on Brazilian plantations, to the most severe and complicated repression of the natural conical or pyramidal shape of the tree, for the purpose of keeping down the height and to provide better access of air and light to the bearing portion of the plant. In some places the entire main stem is cut back after a few years, and vertical shoots from the lower part of the trunk allowed to form new secondary stems. In the same places it is apt to be the practice to cut back the normal taproot of the young

COFFEE PICKING IN LIBERIA

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COFFEE GROWING UNDER SHADE IN COLOMBIA

plant on transferring it from the nursery to the plantation, all apparently with the intention of adapting it better to local conditions of soil and climate, and with the expectation of increasing the yield.

Young coffee plants generally require some shade. Commonly this is obtained by planting a rapid-growing crop such as corn between the rows, but in most countries, bananas or plantains are generally used for the purpose, and serve admirably, except for exhausting the soil ten times as fast as the coffee trees, furnishing the roots of the coffee plants formidable competition for nutritive elements in the ground. In Arabia, fig trees are said to be used at times for shade. Niebuhr observed the use of the Geiger tree which is indigenous there, but reliance is placed rather on planting in shady valleys reached by the sun for only a few hours daily. In the East Indies, Central America, and northern South America, shade trees such as Erythrina, Albizzia, Ingá, and others, are almost always employed to protect the coffee trees from the heat of the noonday sun, from excessive winds, and from the force of rain storms, but on the whole there is as much variety of practice in the provision of shade as there is in the extent and manner of pruning. Leguminous trees of rapid growth with feathery foliage, an open spreading crown, strong branches and deep roots are preferred. In the main coffee region of eastern Brazil, lying between 22° and 24° S. lat., only the young plants are shaded by some temporary cover or cover crop such as corn or mandioca between the rows, discontinued as soon as the trees come into bearing, and no shade trees are used —the explanation being that at the altitude at which coffee is grown there, mostly between two and three thousand feet, meteorological conditions, the proportion of bright sunlight and overcast sky, the amount of wind and rain (1315–1756 mm.) and its distribution, are such that no artificial protection is needed, and the coffee trees flourish under the open sky. There is noted in Brazil,

however, a recent interest in the use of shade trees on coffee plantations for their regulatory action conducive to a more uniform ripening of the fruit.

Coffee in the New World is planted almost everywhere on virgin land cleared by burning the forest. Generally little attention is paid to the matter of fertilizing or preparing the ground or to replacing the elements taken out of it, nor always, unfortunately, to moderating by contour treatment or otherwise, the leaching and erosion of the soil which takes place when the natural cover of forest trees and underbrush is removed and the humus of the forest floor, accumulated during thousands of years, is suddenly exposed to the free play of the elements.

In its native Abyssinia, the coffee tree is a plant of the highlands and, wherever planted, Arabian coffee trees usually thrive best at an altitude of 1,200 to 2,000 meters, 3,000 to 4,000 feet, above sea level, in situations where freedom from frost may be found combined with an annual mean temperature of 60° to 72° Fahrenheit (16°–22° C.), or, still better, approaching as closely as possible to 65° Fahr. (18° C.). In Mexico, where the northern limit is lat. 22° and there is sometimes danger of a cold north wind, it is the rule to plant only where the minimum temperature never reaches 5° C. or within 10° Fahr. of freezing. A prolonged wintry blast would destroy a coffee plantation in a few hours. In the São Paulo coffee district the temperature descends at times to 3° C., and in localities at lower altitudes rarely to freezing.

Rainfall in coffee-growing countries varies from 30 to 120 inches. An annual precipitation of 40 to 70 inches is considered most favorable, but the distribution of the rainfall during the year, absence of heavy rains during the flowering season, and good weather for the preparation of the crop are of greater importance than its exact quantity. Excess of moisture acts to stimulate vegetative development instead of the production of fruit. The

greater the precipitation the greater the importance of a well-drained terrain.

At sea level *Coffea arabica* grows well and flowers, but usually fruits so poorly that its cultivation is of slight if any economic interest. In lowlands it is also greatly subject to the chief fungus disease of the coffee tree known as leaf spot, a rust, *Hemileia*, which has put an end to coffee cultivation in various places where it has appeared, e.g. in Ceylon, Bourbon, and the East Indies. In Mexico it is said that the shrub at 500 feet will produce about one pound per year, at 1,000 feet two pounds, at 2,000 three, at 3,000 even more, but above 4,000 feet the production decreases rapidly. If this is correct, it is easily understood why below 2,000 feet little or none is planted.

Production varies considerably with the age of the tree. The yield may thus vary in different parts of the same plantation and may be twice as great on newly cleared and planted portions as on the old. The average production per tree of some American coffeegrowing countries appears to be as follows: Colombia ¾ lbs. (340 grams), Costa Rica slightly more than ¾ lbs. (350 grams), Guatemala 14 oz. (400 grams), Ecuador 10½ oz. (300 grams). Compared with these figures, the average Brazilian production of 1.5 kilograms or 3.3 pounds appears to be high but probably represents correctly the average for the principal Brazilian coffee region, where a production per tree in especially favorable cases may reach six and a half pounds per unit, and rarely as much as ten or eleven. A São Paulo "tree," however, generally consists of a clump of three or four stems planted together as described above. On the basis of world production for 1931, when the total number of coffee trees existing was estimated at three billions, one arrives at an average of 1⅓ lbs. per tree or 600 grams, which may be accepted as a general average per annum for Arabian coffee. Where, as is often the case, there is a secondary crop following the principal one, this smaller crop may be expected to

yield about one-third as much as the principal one. In some countries there is a third crop due to a third flowering period or there may be, as in places in Central America, an almost continuous production of fruit throughout the year.

Coffeegrowers are likely to discuss production per 1,000 trees instead of average per tree or per hectare, alqueire, acre, or other surface measure.

A statement which embodies the expectations of the coffee planter in Brazil is to the effect that an estate of 80 hectares (125 acres) should produce 50 tons of coffee beans per annum. This would be at least three times the average production in a coffee-producing country such as Mexico.

The character of the coffee produced in any region is determined primarily by the inherent characteristics of the particular variety cultivated, but soil, altitude, and meteorological conditions, as well as cultivation, are important factors governing the size and nature of the crop. In Mexico, according to Villares, coffee grown at 500 meters is thus worth three dollars less per hundred pounds than coffee grown at 1,800 meters. But the quality of the product is to a large extent dependent also on the manner of gathering the crop and its preparation for the market. The hand-picking of well matured fruit only, i.e. dark or purplish, even somewhat past maturity to the point of beginning to be wilted or shriveled, as practised in the countries producing the best grades of mild coffee, ensures a high-class product, while any admixture of green fruit, so-called sunburnt, yellow, dried and spoiled berries, even in very small proportion, is sufficient to ruin the taste or flavor of a large quantity.

As all the fruit on the trees does not mature at once, such hand-picking must be repeated many times and wherever practised prolongs considerably the harvest. It also requires more labor than allowing the ripened fruit to fall to the ground and raking it together at intervals

or stripping the branches of all ripe, near-ripe, and unripe fruit left on the tree, as is often done e.g. in Brazil, where the relatively short harvest season, the magnitude of the crop, and the extent of many of the plantations makes the slower and more laborious process impracticable. However, even in Brazil, the large-scale harvesting of the mature fruit only, is beginning to be practised with the use of vibrators and cloths spread under the trees to catch the crop.

Once they are mixed in gathering, mature and immature fruit cannot well be separated. Such separation as is later obtained by the machine used for removing the pulp from the beans, is at best very imperfect.

The next and most important operation on a coffee plantation is the preparation of the crop for the market. The quality of the final product depends to a very large extent on the manner in which this is managed. There are two distinct methods in use, which may be called the dry method and the wet. The former is the older. It was once general; it is the method used in Arabia and in Abyssinia, and is still the prevailing one on small plantations everywhere and in places where a scarcity of water exists, as in parts of Brazil and in Mexico. The so-called "native coffee" produced in English colonies is almost all prepared by the dry or "poor man's method," which consists in drying the entire coffee berries in the open. The fruit as gathered from the trees is spread out on trays or mats, where small quantities are dried, or on a large scale, on the hard, clean, preferably paved, drying ground in a thin layer which is constantly turned over to secure evenness of drying. It is pushed into heaps and covered to protect it from the heat of the midday sun, and from rain, or, where smaller quantities are handled, on platforms or trays which may be run under cover. The open-air exposure is continued until all danger of fermentation is past, after which further drying may proceed more slowly in ventilated drying bins or barns. The hull or

husk is later crushed and separated from the dried beans by mechanical means. In many places this is still accomplished in the most primitive manner possible in a large wooden mortar, but is usually effected by some form of machine or mill. Small coffeegrowers lacking machinery for this purpose, often sell their product dried in the hull to the larger planters who are better equipped.

The wet process originated on British-owned plantations. It produces so-called "washed coffee" and involves the use of water from the beginning, first to separate the dried and defective fruit and accidental debris from the perfect coffee berries, and then as an aid to freeing the latter from their pulp. Once gathered, the fruit should be freed from its pulp as soon as possible, preferably within some hours of its picking, or, if left till the following day, may be kept cool in tanks of water to prevent fermentation.

The berries are conducted in water to a pulping machine which frees the seeds or beans from the fleshy covering of the fruit, leaving them enclosed only in their parchment coat with at most some adhering shreds of pulp and a slippery coating of saccharine and mucilaginous matter. If allowed to remain during drying, this would promptly start an alcoholic or acid fermentation, which would penetrate the parchment and attack the cellulose of the green and moist beans, thereby injuring the natural color and aroma of the final product. The adhering saccharine substance must therefore be removed as soon as possible. To this end, the coffee from the depulping machines is conducted into covered vats where a controlled fermentation of 12 to 24 hours is allowed to take place in order to destroy or loosen the remains of gummy and sugary matter. This is then completely removed by thorough washing in running water for six to twelve hours.

The cleaned coffee in parchment is then dried, much as in the other method, at first on drying grounds or coffee terraces, generally tile paved or cemented, and finally

dried slowly and more perfectly in covered drying bins or barns, so constructed that every part is reached by forced or natural ventilation.

Natural drying in the open is commonly employed where weather conditions at harvest time permit, as is generally the case in Brazil. Spreading the washed coffee as rapidly as possible in a thin layer in order to get rid of surplus moisture, keeping it constantly stirred or turned over for evenness in drying, using the warmth of the sun of the early morning hour and of the late afternoon as an aid to drying but not permitting any overheating which would be destructive of the volatile oils on which aroma depends, avoiding exposure to moisture of dew or rain, with careful watching throughout the process of drying so that it may be carried just far enough to remove all danger of fermentation—such are the main points observed in the preparation of a high-quality product. The progress of the drying is judged by the color and hardness of the green bean, which, soft in the beginning, become corneous as it dries and fails to dent under pressure applied by the fingernail. The beans are often tested also by biting them and by cutting with a knife to examine the progress of drying of the inside. As the beans dry, the longitudinal groove on the flat side tends to close.

It is generally conceded that the drying of the coffee in the open gives a product superior to that obtained by artificial methods, but in localities where a sufficient open-air exposure is not possible on account of frequent rains, or because of lack of sufficient area of drying ground, a combination of natural and artificial drying is often employed. One or more days of exposure in the open are then followed by several days of treatment in some form of mechanical drier in which the coffee is kept in motion and subjected to forced ventilation at a suitable temperature until quite dry enough. In Colombia further importation of such driers is forbidden as prejudicial to the quality of the product.

Certain countries, such as Java, ship coffee in parchment, and buyers in some European ports prefer to receive it thus, but usually the parchment is removed by a simple mill and blower, and the inner thin pellicle or silver skin, the seed coat proper, is removed by another operation called polishing. At the same time or separately, the dried coffee is subjected to a mechanical cleansing or winnowing to remove sticks, broken beans, small particles and dust, etc. By the use of a succession of sieves it is then mechanically graded according to size of the beans and, where the highest grade of product is desired, subjected to a final elimination of defects by careful hand-picking. Remaining foreign matter, such as small sticks and stones, as well as husks and broken, discolored or otherwise defective beans, are thus eliminated, before the coffee is finally placed in bags. Throughout the whole process of preparation there is a gradual reduction in bulk. It is usually estimated that five or six pounds of Arabian coffee berries give one pound of dried coffee beans.

THE SPREAD OF COFFEE CULTIVATION

The coffee district of Arabia constitutes less than 2% of the area of that sandy and mostly rainless peninsula. It is only in the mountains and highlands of its southeast corner that the monsoons in spring and early summer bring sufficient precipitation to permit the maintenance of the Arab's terraced coffee gardens. These are generally located on some slope or in a valley of the few mountains which rise above the general level of the highlands, in situations where partial shade prevails and where it is possible to obtain water for irrigation from the mountain springs or brooks. The district extends from Aden to Loheia, 13° to 16° N. latitude, the most important part being Yemen al-a'lā. Beit-el-Fakih, the coffee capital, Hodeida, Sana, and Tais are other important points of the coffee-producing area.

The production of the small Arabian coffee area was never very great, and even when augmented by contribu-

HARVEST TIME ON A BRAZILIAN COFFEE PLANTATION

DRYING COFFEE ON A SMALL PLANTATION IN COLOMBIA

tions from southern Abyssinia, would have been insufficient for any widespread consumption beyond the eastern end of the Mediterranean. From Arabia, however, coffee cultivation soon spread to other parts of the world.

Coffee is said to have been carried to Ceylon in 1505 by a traveling Arab and to have been planted in Mysore, India about 1600 by a returning pilgrim who brought seven seeds. In spite of a strict prohibition after the trade had begun to take on some importance, viable seeds were carried to Ceylon (1690) and soon afterwards to Malabar and to Batavia in Java. The first plants introduced into Java were destroyed by a flood, but a second attempt with plants from Malabar was successful and laid the foundation for the coffee industry of the Dutch East Indies, and incidentally, furnished the plants which, by way of Amsterdam, became the ancestors of most of the coffee trees in the New World. The first sample of coffee grown near Batavia was sent to Holland in 1706. The first commercial shipment of coffee, of 894 pounds, was made five years later. Accompanying the former was a branch of the coffee bush which was studied by the botanist Commelin, and a single potted plant for the botanic garden of Amsterdam which had the first greenhouses in Europe. Descendants of this plant were distributed to other botanic gardens of Western Europe, and plants or seeds were later sent to the Dutch West Indies and to the Dutch colony Surinam in South America.

The story of how, after the peace of Utrecht, a coffee plant was sent to the king of France, has been retold so many times that it seems best to quote an early version as found in John Ellis, *Historical Account of Coffee* (1774), pp. 16–17:

"The first account of this tree being brought into Europe we have from Boerhaave, in his *Index of the Leyden Garden*, part 2, page 217, which is as follows: 'Nicholas Witsen, burgomaster of Amsterdam, and governor of the East India Company, by his letters often

advised and desired Van Hoorn, governor of Batavia, to procure from Mocha, in Arabia Felix, some berries of the Coffee-tree, to be sown at Batavia; which he having accordingly done, and by that means, about the year 1690, raised many plants from seeds, he sent one over to governor Witsen, who immediately presented it to the garden at Amsterdam, of which he was the founder and supporter: it there bore fruit, which in a short time produced many young plants from the seeds.' Boerhaave then concludes that the merit of introducing this rare tree into Europe is due to the care and liberality of Witsen alone.

"In the year 1714, the magistrates of Amsterdam, in order to pay a particular compliment to Louis XIV, King of France, presented to him an elegant plant of this rare tree, carefully and judiciously packed up to go by water, and defended from the weather by a curious machine covered with glass. The plant was about five feet high, and an inch in diameter in the stem, and was in full foliage, with both green and ripe fruit. It was viewed in the river, with great attention and curiosity, by several members of the Academy of Sciences, and was afterwards conducted to the Royal Garden at Marly, under the care of Monsieur de Jussieu, the king's professor of Botany; he had, the year before, written a Memoir, printed in the History of the Academy of Sciences of Paris, in the year 1713, describing the characters of this genus, together with an elegant figure of it, taken from a smaller plant, which he had received that year from Monsieur Pancras, burgomaster of Amsterdam, and director of the botanical garden there."

The Regent of France, the Duc d'Orleans, and the French Academy of Sciences took an active interest in the introduction of economic plants into the French colonies. The King brought trees of cinnamon, pepper, and cloves to send to the West Indian Islands and (even before 1700 ?) had sent coffee seeds to Haiti. In 1716,

the Royal Academy of Sciences decided to send a representative to Martinique to cultivate useful plants and to report on them, and selected for the purpose M. Isambert, a physician, apothecary to his Royal Highness the Regent. He sailed with bees, silkworms, and some plants among which were three coffee trees, and he was given particular instructions relative to their care, but unfortunately this emissary of the French Academy died almost as soon as he had arrived at his destination. Requests for a repetition of the attempt at introduction of coffee were opposed by the French India Company.

Soon after its arrival in Amsterdam, coffee had been sent to the island of Curaçao and in 1714 was introduced into the Dutch South American colony, Surinam or Dutch Guiana, where it prospered. A Frenchman named Morgue from Cayenne, said variously to be a prospector or a runaway soldier, who had taken refuge in Surinam, returned about 1719 to the French colony carrying, perhaps by previous arrangement with the authorities in Cayenne, coffee seeds which were planted in the garden of the governor, M. de la Motte Aigron. These, with further seeds obtained the following year by a detachment of soldiers from Cayenne searching for prisoners across the Surinam border, had by 1723 produced ten thousand plants. In 1720, coffee was carried from Surinam to Barbados by a Captain Young and probably was supplied to French West Indian Islands from Cayenne.

Its introduction into Martinique, however, has generally been credited to a French Naval Lieutenant, De Clieu, long stationed in the West Indies, who had gone to France in 1718 but had occasion to return to Martinique. This officer has become a French legendary hero through his account of sharing his scant ration of drinking water with the coffee plant. The single plant he carried, obtained from the royal garden in Paris five years after the unfortunate mission of M. Isambert, arrived safely in Martinique, and produced fruit in 1721,

in time to furnish seed for a new and valuable cultivation to take the place of the cacao (introduced 60 years earlier) which had been destroyed by an earthquake or hurricane. According to M. Chevalier, the only existing account of this feat and all subsequent romantic versions of it were based on letters written by De Clieu himself fifty years later, one of them to the botanist Aublet, another to the editor of a periodical, both of which were published. From Martinique, coffee cultivation spread rapidly to neighboring islands, first to Guadeloupe, where in 1777 there were 18 million coffee trees. Concerning its introduction into Haiti and San Domingo, there are conflicting statements. It was introduced into Jamaica in 1728 and soon afterwards into the Spanish islands of Cuba (1748) and Puerto Rico (1755). Before the end of the eighteenth century the production in the French possessions in the West Indies had grown to 50,000 tons, sufficient to supply not only the mother country but also the larger part of the entire European consumption of that time.

From French Guiana, five coffee plants and more than a thousand fruits were carried to Pará, in the Portuguese colony of Brazil, in 1727, by a Brazilian officer, Palheta, returning from a border mission to Ceyenne. Pará, at the mouth of the Amazon, does not offer especially favorable conditions for growing coffee, but its cultivation was encouraged by the governor, and in 1732 seven pounds of coffee were sent as a sample to Lisbon, the first Brazilian shipment of coffee. In 1755 there were 17,000 coffee trees in Pará, and 967 bags of 160 lbs. each were shipped to Portugal. Some forty years after its arrival in Pará, coffee reached São Luis, in the adjoining state of Maranhão. From São Luis it was carried to Rio de Janeiro in 1774. From there plants were distributed throughout eastern Brazil where, especially in the highlands of São Paulo, the Arabian coffee found soil and climatic conditions apparently more favorable to its growth than those existing in its homeland or encountered in any other part

of the world where it has been introduced. The first export shipment from the present Brazilian coffee district, was made from Rio in 1800 and consisted of 13 bags. From southeastern Brazil, coffee reached Paraguay, Chile, and Peru.

Before the end of the eighteenth century, Spaniards from the West Indies had carried coffee to Venezuela (1740) and other countries of northern South America—Colombia, Ecuador, and Bolivia—also to Central America, perhaps first to Costa Rica and to Mexico (1790), whence it spread (1850–52) to Guatemala. The coffee of Salvador is said to have come from Cuba.

Africa, the original home of coffee, is the last continent to enter upon its large-scale production for the world market. Plantations have been developed in many places in West as well as in East Africa, most recently in British Kenya, but the total production of the continent is still relatively small, as is that of the Asiatic mainland. The Philippine Islands grow some coffee, as do Hawaii and various Islands of Oceanica, but their total in percentages of world production is small.

THE COFFEE TRADE

WORLD PRODUCTION AND CONSUMPTION

As an article of trade, coffee is said not to have been greatly appreciated by the Arabs until the arrival of European merchants. These were Portuguese (1500) who had just circumnavigated Africa, Turkish traders from the north (1530–40), and later ships of the British East India Company (1610) and Dutch (1614) merchantmen stopping on their way to or from the Indies. During the early days of its introduction in Europe the Arabian crop went north from Mocha by way of the Red Sea to Cairo and Alexandria in Egypt and to Stamboul on the Bosphorus, as points of final distribution.

The first port in western Europe to engage in the coffee trade, Marseilles (1660), obtained its supplies in Cairo

and for some time enjoyed virtual monopoly of the supply in the West until the merchants of St. Malo brought coffee directly from Aden or Mocha by way of the long seaward journey around Cape of Good Hope (1708–1713). Soon afterwards the French India Company was formally granted the sole right to supply coffee to France (1723). With the shift to the maritime route, and for other reasons, Mocha lost its importance as a coffee mart, its place being taken by Hodeida and Aden. By 1800 the coffee-carrying trade was handled largely by American clippers, the whole export being then 16,000 bales of 305 pounds each, and was laid down in Europe at a price with which the India Company could not compete.

When the Dutch began to plant coffee in the East Indian islands and the product was sent directly from Java to Amsterdam, the situation altered. The available supply was soon greatly increased and exclusive dependence on the Arabian production came to an end. Three million pounds were received in Holland in 1745. Coffee had also been introduced in 1717 into the French islands of Ile de France and Bourbon or Réunion off southeast Africa, whence 360,000 pounds were exported in 1730. From Bourbon it was later introduced into Madagascar.

When the French West Indies, particularly Martinique, asked permission to send coffee to France, this was at first refused as interfering with the India Company's privilege, but on repeated representations it was afterwards granted by the King on condition that the product be received in French ports for sale only to other parts of Europe. The French consumption at that time was six to eight thousand tons, while the West India production aggregated fifty thousand.

English plantations in Ceylon and in India soon made of London also a coffee port, though less important than the continental ones. The French plantations in Bourbon were not a success, and with the loss of Haiti and other difficulties in the West Indies, the production of the

French colonies had dropped at the end of the 18th century to 500 tons. The Napoleonic wars then interfered with the European trade, the English blockade shutting off coffee imports to the continent.

Coffeegrowing in the New World increased in the meantime, especially in eastern Brazil, which, beginning its export with a trifling quantity in 1800, became an important factor from 1835 on, exporting a million bags in 1850, 2 millions in 1860. With the great destruction of plantations in Ceylon, Java, and Sumatra in the last quarter of the past century by the fatal leaf-spot disease, the greater part of the coffee trade passed definitely to the Western Hemisphere. The United States had become the greatest market for the product not only because of its great increase in population but also owing to a rapidly growing per capita consumption. In 1850 this was four and a half pounds per person per year. It has since grown to twelve pounds and is exceeded now only by the per capita consumption of the Scandinavian countries, Denmark with 17½ pounds and Sweden, with 17 pounds per capita per annum, holding the primacy in this respect.

Imports to the United States were about 5¾ million bags or 748 million pounds in 1900. In 1930 these had risen to 12 million bags or 1,570 millions pounds, in 1935 to over 13 million bags, one-half of the world consumption. France is the second largest consumer with 3 million bags, Germany third with 2 to 2½.

In 1900 the world's production and consumption of 10 million bags practically balanced. Since then there has been a steady growth in consumption (23,900,000 bags in 1931–32) accompanied by an extraordinary and speculative striving for the largest possible production (37,500,000 bags in 1931–32, 39,700,000 bags in 1933–34). Continuous expansion of the coffeegrowing area has resulted in the existence of 4 billion coffee trees in the world, of which 2,967 million in Brazil, half of them in São Paulo with some nine million acres of coffee planta-

tions, and the production of a huge unsaleable surplus. While the world production of coffee has doubled in the last 20 years, that of Brazil has tripled. In its effort to avoid the unfavorable effect of this on the market price, Brazil since 1931 has destroyed by burning 60,000,000 bags of coffee. Its exports in 1936 were 14,180,000 bags of 132 lbs. each, or 1,701,600,000 lbs. out of a total world consumption of 3,100,000,000 lbs. The Brazilian surplus at the end of 1937 is said to be 17,500,000 bags.

The second largest producer of coffee is Colombia with 4,000,000 bags in 1937, one-fifth as much as Brazil. The Dutch East Indies with 1,650,000 bags are third in rank; Salvador, Venezuela, Guatemala, Mexico, Haiti, and Costa Rica, fourth to ninth.

When 15,000,000 bags of coffee were produced in a year practically all was consumed. Of the 38,000,000 bags produced in 1936, 24,000,000 were consumed. The unused surplus was greater than the whole annual production of twenty years before.

OTHER SPECIES OF COFFEE

In the preceeding pages, coffee has been treated as if it were the product of a single species, viz. Arabian coffee (*Coffea arabica* L.), which is practically the only species grown commercially in the New World, producing more than 90 per cent of the world's coffee crop. But since coffee became a commodity of world-wide interest, botanical exploration in Africa has brought to light the existence of numerous other species of the genus *Coffea*. About one-half of these, or eighteen, grow spontaneously in tropical West Africa, while of the rest, three grow wild in southeast Africa and three are native in the islands of Madagascar, Bourbon, Mauritius, etc., off the southeast African coast. A few species of the genus *Coffea* have been found in southern India, Java, Sumatra, and one in New Guinea, but most of these belong to a section of the genus which does not furnish coffee for beverage purposes. Some of

DRYING COFFEE ON A MEXICAN PLANTATION

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HULLING DRIED COFFEE WITH MORTAR AND PESTLE IN MEXICO

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these species of *Coffea* are very handsome plants when in flower. Many of the African species have been tried with some success for coffee production, and a few of them are being grown commercially in situations and under conditions unsuitable for Arabian coffee, in Africa, in India, and in the East Indian Islands.

The best known of all competitors of the Arabian coffee plant is the Liberian coffee, *C. liberica*, a lowland plant, larger and more robust than *C. arabica*, with large leaves and flowers and bearing larger fruit. Contrary to early optimistic expectations entertained for this species, it has been found to be subject to leaf-spot disease and yields a product which is not greatly esteemed. A coffee tree of Belgian Congo (*Coffea canephora* var. *Laurentiana*) known by the horticultural name *Coffea robusta*, has been widely planted in Java to replace the Liberian coffee once grown there but abandoned. Robusta coffee is esteemed for its rapid growth and its precocious and high yield, but furnishes only an inferior grade of coffee. It is planted, however, in sufficient quantity to constitute six per cent of the world's production. Most of its product is sold by the Dutch to those European countries where coffee is habitually mixed with substitutes, especially chicory, and where quality is therefore not demanded, but a part of it finds its way to the United States, where it is purchased as a so-called price coffee and used by some American coffee roasters as "fillers" in their blends. The Dutch islands Java and Sumatra thus furnish a small quantity of the highest-grade coffee from Arabian trees grown in the mountains, about 10% of their production, and a large quantity of some of the poorest or *robusta* coffee, known also as Palembang, grown at lower altitudes.

A species from Ubangi, a tributary of the Congo, "Chari" coffee (*Coffea excelsa*), so named from the Chari River, is the largest of all coffee trees, growing commonly twenty to forty feet, and even to sixty feet high. It is of some interest in the Old World tropics, Indo-China,

etc., for its adaptability to a variety of conditions not suitable to *C. arabica* and yields a product said to be superior to *C. liberica* and *robusta*.

A variety of *Coffea arabica* found in Grand Comoro Island is entirely devoid of caffeine. A species from the Mascarene island of Réunion or Bourbon and from Madagascar has only a trace of caffeine, but also poisonous properties. Another species of Madagascar is too bitter to be used.

The systematic relationship and genetics of the many species and varieties of coffee still await more thorough investigation which may prove to be of great practical importance to the coffee industry in general. The Dutch agricultural stations in Java have been active in this direction. At present there is no general agreement about the relative merits of the more recently discovered and less cultivated species of coffee, but they are a matter of great interest to colonial governments in Africa, Asia, and the East Indies, where conditions for growing Arabian coffee are not favorable and a satisfactory substitute would therefore be welcomed which would permit competition on somewhat more equal terms with the coffeegrowing countries of the New World.

COMPOSITION OF THE COFFEE BEAN—CAFFEINE

COFFEE ROASTING

The main stimulative constituent of coffee is the alkaloid caffeine, first found by the chemist Runge who extracted it from coffee beans in 1820, about the time alkaloids were first discovered in plants. Caffeine has since been found to exist in all parts of the coffee plant, especially in the leaves. The significance of the presence of such substances and their place in the economy of the plants in which they are found are not well understood. Their chemical composition and physiological action is much better known. Caffeine is thus described chemically as a purine base, tri-methyl-xanthin, $C_5\ HNO_4\ O_2\ (CH_3)_3$

and may be synthetized. Isolated in its pure state it forms masses of silky, needle-like, white crystals. Its physiological action in small doses, such as are found in a few cups of coffee of ordinary strength, is that of a stimulant, producing a feeling of physical well-being, increasing mental activity by its action on the central nervous system, relieving fatigue and promoting muscular activity including that of the heart and of the alimentary tract. It is eliminated through the kidneys after some hours and increases their function.

The fact that its stimulating action is not followed by depressing after effect, as is the case with practically all other stimulants, is very important, and has contributed to the widespread use of coffee as a beverage, though the pleasant and distinctive aroma is unquestionably also a factor contributing to its popularity.

Caffeine is now known to exist in many other plants besides coffee. The alkaloid called "theine," discovered in the leaves of the tea bush, is identical with caffeine. Tea dust, from which it may be extracted much more economically than from coffee, is in fact the commercial source of most of the caffeine used for medicinal purposes. Cola nuts, the seeds of Guaraná, and the leaves of Maté and of various other species of the Holly family are also used for beverages that owe their stimulating properties to their caffeine content. The principal alkaloid of cacao, theobromine, is very similar to caffeine, which is also a constituent of cacao.

Caffeine content varies considerably in the different species and varieties of coffee from none at all in one noncommercial species to as much as three per cent by weight. In the varieties of Arabian coffee commonly used, it varies from one-half to two and a half per cent, the highest caffeine content being ascribed to coffee from Colombia, the lowest to that from Mexico. Brazilian and Guatemalan coffees are intermediate with three-quarters to one and a third per cent. The average caffeine

content of coffee beans is often stated to be one and a half per cent.

A comparison of coffee and tea is frequently attempted on the basis of their respective caffeine content, usually expressed in percentages of dry weight. On this basis, the caffeine content of tea is found to exceed greatly that of coffee. The comparison ordinarily intended is that of the caffeine content of the beverage, for which a much smaller quantity of the dry weight is required of tea than of coffee, equalizing the difference. A cup of either coffee or tea as ordinarily prepared is thus found to contain about the same quantity of caffeine, about one and a half grains. Both have in addition other important constituents and aromatic substances, especially the volatile oil on which fragrance or aroma depends.

In coffee, the aroma is developed by the process of roasting, which also serves to break down the cellulose walls of the cells of the bean, facilitating the grinding or pulverization necessary for the liberation of the soluble substances and other ingredients contained in the bean. The amount of these extracted from the ground coffee in the process of preparation of the beverage may be judged by the difference in weight of coffee used, and weight of coffee grounds dried after making, which is found to be about 25 per cent.

The roasting of coffee is said to have originated in Persia. In many places, especially in coffeegrowing countries, the roasting of the required quantity of coffee beans over a charcoal or other slow fire is still an indispensable preliminary and part of each preparation of the beverage. In other places where less importance is attached to coffee-making, sufficient coffee is roasted at one time to last for several days, enough being crushed or pounded afterwards in a mortar, or ground, to serve as desired for each occasion.

In the United States, however, and wherever the convenience of package goods and trade-marked blends

have become the order of the day, coffee is roasted in quantity.

The roasting is begun at full heat, checked toward the end of the roast, with the coffee kept in constant motion in revolving drums or otherwise. The humidity which is given off and the gases developed in the roasting process are allowed to escape or are removed by forced ventilation until the operation is completed. The roasted beans should then have a uniform brown color and a characteristic pleasant flavor. If the heat is not even, or is too high, during any part of the roasting, the result is a charring and blackening of the beans with a loss of the aromatic essential oil and development of an unpleasant odor and taste.

Ordinary grades of badly prepared coffee beans present a speckled and variegated appearance after roasting, with some beans shriveled and black; others, the imperfectly mature ones, lighter in color than the rest, conspicuously yellow to light brown. A mixture of large and small beans also roasts unevenly, the small kernels becoming roasted first.

Sometimes, as in Mexico, sugar is added during the roasting in the belief that it will facilitate the formation of flavor and retain the aroma. Owing to the increased amount of heating required to caramelize the added sugar, the result is usually the contrary of what is expected.

To stop the changes taking place in the heated beans, the roasted coffee is spread out at once to cool. It is found to have lost in the process about 12% to 18% of its weight and to have increased about one-third in volume.

Unroasted coffee may be kept for many years and improved in quality with a certain amount of ageing, though to this there are said to be exceptions, the question being one of slow chemical changes, favorable or unfavorable to flavor, which may take place in the bean. Roasted coffee, on the other hand, deteriorates with rapidity. The loss of aroma which takes place in a short time in

roasted coffee is due to the combination of some of its constituents with the oxygen of the air. There is enough of this in the ordinary coffee can to cause a decided loss of aroma, less in vacuum-packed cans in proportions to the perfection of the removal of the air at the time of packing. The staleness, which appears even before the aroma has completely disappeared, has been attributed, perhaps incorrectly, to changes producing rancidity of the fixed oils in the coffee bean, which are not completely destroyed in the process of roasting.

The composition of the green coffee is given roughly as cellulose 34%, oils and fats 10 to 13%, sugar 7%, protein 14%, water residual after drying 12%, plus various other substances in smaller quantity.

The exact nature of the chemical changes which take place in the roasting of the beans is a matter of somewhat complicated organic chemistry. Sugar and starches are caramelized and produce various new compounds. The volatile oily substance called caffeol, considered the chief factor in the aroma, is thought to be produced when caffeine, sucrose, and caffetannic acid are heated together. Caffetannic acid, however, is held to be a problematical substance or at least a misnomer, and no tannin or tannic acid is present in the roasted bean. The fixed oils are mostly olein, also palmitin and stearin, and there are present besides, various free fatty acids, and substances such as furfural, pyrol, etc. Carbon dioxide and, to a less extent, monoxide gas is evolved. A certain amount of carbon dioxide is retained or is residual in roasted coffee and in a vacuum pack replaces the exhausted air. Since the discovery of caffeine, more than a hundred years ago, a large amount of chemical research has been done on coffee, but the chemical changes which take place in roasting are still imperfectly understood. One investigator sums up the present status of this subject by saying that there is no doubt that compounds other than those isolated to date are necessary to produce the aroma.

COMMERCIAL CLASSIFICATION OF COFFEE

The many kinds of coffee sold in the coffee markets of the world are generally distinguished first of all according to their geographical origin, e.g. Brazilian coffee, Java Coffee, Costa Rican Coffee, etc., and in the case of the larger producing countries also more specifically by the name of the port from which they are shipped, or of the district, or sometimes of the trading center from which they are derived.

Coffee from the Brazilian state of São Paulo is thus generally known as Santos Coffee, Santos being the port from which its exportation takes place. Coffee from the district which finds its commercial outlet through the port of Rio de Janeiro is called Rio Coffee, whether grown in the State of Rio de Janeiro, in Minas Geraes, or in southern Espirito Santo, though Minas coffee may also come on the market as such. Victoria Coffee, mostly from the Brazilian state of Espirito Santo, is exported through the port of Victoria. Bahia, Pernambuco, Paranaguá, and Angra dos Reis are other Brazilian coffee ports of less importance.

Venezuelan coffee is shipped from Maracaibo, from Caracas, or rather from its port town, La Guaira, and from Puerto Cabello. A certain amount of eastern Colombian coffee finds its outlet through the first-named port. Colombian coffees are generally known by the name of the districts in which they are produced as Medellin, Armenia, Manizales, Bogota, Bucaramanga, etc., shipped from Atlantic and Pacific ports of Colombia. The Mexican coffees best known in the United States are shipped mostly from Veracruz, viz. Coatepec, Huatusco, Córdoba, Orizaba, etc., produced in the state of Veracruz; Oaxaca, in the state of that name, and Tapachula, in Chiapas.

On the other hand, where not distinctly forbidden as in the United States, coffee grown in Sumatra or other East Indian islands is often designated as Java, the latter

being famous as a coffeegrowing country and still enjoying a high reputation for a part of its product. Only a very small part of the coffee called Mocha in the world trade is actually derived from Arabia or from Abyssinia, the rest of so-called Mocha consisting of mocha type, small rounded, preferably gray-green beans from almost any place, e.g. Tepic, Mexico. In Brazil peaberry coffee, so-called caracol or caracolillo of Spanish-American countries, a rounded bean formed where only one seed of the fruit develops, is known as mocha, moka or mokinha. Little if any Bourbon coffee now comes from the island of that name, where, early introduced from Mocha, it once flourished for some time. Most of the Bourbon is probably grown in São Paulo, Brazil, especially in the district of Riberão Preto, and is thus Bourbon Santos, and, whether originally brought from the island of Bourbon or not, in the course of long replanting in Brazil has become a well established variety by that name. Maragogipè, also a Brazilian coffee, is a large-seeded variety originating as a mutant in a place by that name in the state of Bahia. It is now grown in various other countries, especially in Mexico.

It is thus seen that a name of a geographical locality known or famous for a certain quality or kind of product is apt to be used by extension to indicate characteristics or type of product rather than origins, quite apart from intentional misbranding. The words Java and Mocha have thus been used freely to designate certain kinds of coffee ever since the beginning of the European coffee trade. Misuse of such geographical designations for coffee is now prohibited in the United States by regulations of the Federal Food and Drug Inspection. Java may be applied only to the product of *Coffea arabica* or *liberica* actually grown in that island. Robusta coffee from Java must be labeled "Java robusta" and is now denied consular invoice if reshipped from Europe as e.g. Rio. Mocha must be produced in the district of Yemen, Arabia.

A SAO PAULO COFFEE PLANTATION WITH ITS EXTENSIVE DRYING GROUND

Photo from Coffee Institute of São Paulo

Copyright by Theo. Preising

WASHING COFFEE ON A BRAZILIAN PLANTATION

In coffee from the Dutch Indies and from English possessions in India and Africa, a distinction is made between plantation coffee and native coffee, the latter the product of small growers, the difference being usually of the method of preparation, wet or dry, represented also by the term washed and unwashed coffee.

According to the number of defects present, whether in the form of broken beans, shells, unripe or scorched or blackened beans, fragments of sticks or small stones, coffee is graded into eight numbered types, number one representing perfection, perhaps never attained, eight the lowest type permissible on the New York Coffee Market. Prices of Santos coffee are quoted for No. 4, of Rio for No. 7, of Colombian coffees for Manizales, prices of other grades being in definite and constant proportion.

As to beverage making qualities the coffees most generally used are divided into three main groups, mild, soft, and hard. The term "mild coffees," or milds, is generally applied to coffees grown in Colombia, Venezuela and all the Central American countries, when the production is almost entirely of "washed" coffee. It is also applied to Mocha as well as to the small amount of high class coffee of Java and Sumatra. The term is sometimes used as a synonym for "washed" coffees, though it includes Mocha which is always prepared by the dry method, and is applied to all coffee from the Colombia–Central American region whatever their manner of preparation. These coffees are recognized as having no hard or harsh flavor, but in spite of the designation "milds" have a heavier "body" than Brazilian coffees, so that a relatively small proportion of them can be used in mixtures to impart this character to a beverage made of lighter bodied coffee, such as Santos. Santos coffee is described as "soft" or, when carefully prepared, "strictly soft." This term is used, rather than "mild," to distinguish Santos from Rio coffees which latter are apt to have a harsh or acrid taste and are therefore spoken of as "hard." This

character, in the opinion of Brazilian coffee experts, is probably owing less to conditions of soil, climate, or altitude at which grown than to prevailing methods of harvesting a mixture of ripe, unripe, and spoiled fruit and a traditional lack of care in drying, preparation and subsequent handling, conditions which the Brazilian coffee growers are actively endeavoring to improve. Coffees made from fully ripe fruit only, are devoid of the harshness characterizing the hard, and yield a beverage of a finer aroma. The milds of Colombia, Venezuela, and Central America and the "strictly softs" of Brazil are readily absorbed by the coffee trade, as are the high class coffees of Netherlands Indies, and the Arabian Mocha. The latter goes mostly to Levantine countries.

COFFEE SUBSTITUTES AND ADULTERANTS

The European travelers who first penetrated beyond the sources of the Nile found the natives making use of the coffee fruit, boiled, mixed with fat and made into balls, which, constituting both food and stimulant, were carried as provisions on their expeditions. The use of roasted beans for the preparation of a beverage was not observed, but leaves of the coffee bush were used as tea in Ethiopia, and in Abyssinia a drink called *kisher* was prepared from the dried and toasted pulp of the coffee berry. This is the so-called Sultan or Sultana coffee, widely used in Yemen. It is described as of a golden yellow color and of an agreeable, somewhat sweet flavor. Various travelers aver that in the Arabian coffeegrowing district this infusion is commonly employed for local consumption in preference to the beverage made from the bean.

In Arabia and in all the Levantine countries, the roasted coffee beans are pulverized and the grounds are consumed with the liquid. Anise-seed, cardamom, cloves, or other spice may be added for flavor. The addition of sugar to coffee is thought to have originated in Alexandria where the sugar cane was cultivated, or is ascribed to

Constantinople. Milk or cream in coffee was apparently first advocated in France, where coffee was recommended to be made with hot milk instead of water.

As the use of coffee became popular in Europe, where its price long remained high, attempts were made by consumers to find a cheaper substitute in part or whole, and by venders to find an adulterant which would pass unperceived. Chemists were even ordered by the Prussian government to find a substitute. Almost everything that could be dried, roasted, and ground to look like coffee has been tried.

The most popular of all adulterants is chicory, prepared from the dried root of a European wild plant of the daisy family. The use of this is said to have originated (1790) in Batavia in Holland, and during the Napoleonic wars, when coffee increased excessively in price and with the English blockade of the ports became almost unobtainable, the cultivation of chicory as a field crop became extensive in Central Europe. It has been commonly employed ever since and is now widely grown especially in Belgium, Germany, and northern France.

Alleged harmful properties of coffee have furnished the excuse for many enterprising attempts to produce a preparation which would give a coffee-like beverage without the use of coffee beans. Roasted cereals of all kinds, bran, malt, special doughs, potatoes, carrots, beans, particularly soy beans, peanuts, peas and other legume seeds, especially of Lupin, Cassia, and St. John's bread, sunflower seed, cotton seed, acorns, chestnuts, horse chestnuts, black figs and prune pits, usually with chicory and with molasses or some form of caramelized sugar—mostly the same substances that have been employed as adulterants, of which Field Museum has an extensive collection—furnish the ingredients of many varieties of so-called "health coffee."

To satisfy those who for some reason seek a coffee-like drink without the caffeine content, industrial methods

have also been devised for removing the caffeine from coffee beans.

An unusual coffee substitute, employed in the drought area of Brazil, consists of the seeds of the Carnaúba or wax palm. As material for a beverage, these are probably about equal in value to dried olive pits, but are resorted to locally in times of great want in places remote from coffee-producing areas.

The demand for a satisfying warm beverage which will serve to promote a feeling of physical comfort, appears to be so well supplied by coffee that when this cannot be obtained those accustomed to its use are impelled to seek a substitute, however poor.

With the world's coffee production greatly in excess of the demand and steadily increasing, with a decrease in price, the incentive to adulteration or need for substitution is rapidly diminishing. In the United States the enforcement of pure food laws insures effectively against misbranding and fraudulent substitution.

An extensive discussion of methods of coffee-making, including reports and opinions from competent experimenters who have made special study of the subject, may be found in the chapter entitled "Preparing the Beverage" in Uker's, *All about Coffee.*

The conclusions there found may be condensed from a summary by Dr. Prescott of Massachusetts Institute of Technology as follows: The best results will be obtained with freshly roasted coffee, finely ground but not pulverized, infused at temperatures 185° to 195° F. (85° C.–90° C.) for not over two minutes in a glass, porcelain, or vitrified container, and the liquid immediately filtered from the grounds. The reason for avoiding the use of metallic containers is that coffee infusion reacts with metal, and tin plate, aluminum, copper, and nickel all effect the taste. Boiling or prolonged contact with the grounds increases the bitterness of the beverage, and

SEPARATING DEFECTIVE BEANS BY HAND IN COLOMBIA

SANTOS

BOGOTA

COFFEE IN PARCHMENT

JAVA

MOCHA

PEABERRY COFFEE

boiling coffee serves to perfume the house by diffusing the aroma which should be reserved for the cup.

THE LITERATURE OF COFFEE

The first mention of coffee in European literature is by the German physician Rauwolf, who had visited Syria and on his return published (1573) an account of his travels, describing a drink which he had seen in Aleppo, made from the fruit *bunna*. The following year the Dutch botanist, Clusius, described some coffee beans received from a colleague in Ferrara. The earliest description of the plant is that of the Venetian physician, Prosper Alpino, who had visited Egypt and published (1592) a volume on the plants he had found there. His description of a coffee bush from Arabia Felix is accompanied by a poor drawing. The first correct delineation of a coffee branch is that accompanying Jussieu's description (1713) of the plant sent to Paris from Amsterdam.

The Arabic manuscript by the Sheikh Abd-al-Kader or Ghaffer, preserved in the royal library at Paris, has been translated in part and abstracted in French by A. Galland, *De l'origine et du Progrès du café sur un manuscrit arabe etc.*, Caen, 1699, and in German by Sontheimer in *Wissenschaftliche Annalen der gesamten Heilkunde*, Berlin, 1834.

The principal accounts of early visits by European travelers to the Arabian coffee district are those of Jean de la Roque and of Karsten Niebuhr.

La Roque's *Voyage to Arabia Felix* is an account of the expedition sent by the merchants of Saint-Malo (1709–12) to bring coffee directly from Mocha and includes two chapters by Grelaudière on the coffee tree and its fruit. Niebuhr's *Travels and Description of Arabia* contains the observations made by a scientific expedition sent by the King of Denmark in 1762. The group of five men of which it was composed, headed by the botanist Forskal with Cramer as surgeon and zoologist and Niebuhr,

an army officer, as geographer and surveyor, was soon reduced by death to three, viz. Niebuhr, an artist, and a servant—finally to Niebuhr alone, who remained to set down and returned to publish his own accurate and excellent observations in addition to the notes left by his companions. Hogarth's, *The Penetration of Arabia* (1904), Wyman Bury, *Arabia Infelix* (1915), and that remarkable book of travels among the Arabs, Doughty's *Arabia Secreta,* all devote at least some pages or paragraphs to an account of coffee in the land of Mahomed.

The bibliography of coffee is voluminous. Outstanding recent works are Cheney (R. H.), *A Monograph of the Economic Species of the Genus Coffee,* New York, 1905, and Ukers (Wm. H.), *All About Coffee,* New York, 1935, the former mostly botanical and technical, with taxonomic bibliography; the latter an encyclopedic account by the editor of *The Tea and Coffee Journal,* of coffee in all its aspects, with extensive bibliography.

The most recent scientific monograph on coffee is by a French authority, Aug. Chevalier, *Les Caféiers du Globe,* of which the first part only has been published. A recent German treatise on coffee and its cultivation, with an extensive list of the animal and vegetable parasites and pests of the coffee tree, is by A. Sprecher von Bernegg in *Tropische und Subtropische Weltwirtschaftspflanzen,* Stuttgart, 1934.

The most comprehensive account of conditions and methods of production in all principal coffeegrowing countries of the world, is by George Dumont Villares, *O Café,* a report to the government of the State of São Paulo, Brazil, 1925.

Coffee, *The Epic of a commodity,* the Viking Press, New York, 1935, is a journalistic account, originally written in German by H. F. Jacob, of the history of coffee, its introduction in Europe, with special reference to the relation of coffee drinking to manners and social customs.

WORLD'S COFFEE PRODUCTION 1936 (lbs.)
(Internat. Inst. Agric.)

Brazil	2,871,310,000
Colombia	492,735,000
Salvador	143,301,000
Venezuela	157,852,000
Guatemala	147,710,000
Mexico	99,208,000
Haiti	77,162,000
Cuba	50,706,000
Dominican Republic	42,990,000
Costa Rica	52,911,000
Nicaragua	35,274,000
Puerto Rico	19,842,000
Various others	119,051,000
Total	4,310,052,000
Netherlands Indies	235,895,000
India	33,069,000
Ethiopia	44,093,000
Tanganyika	29,983,000
Kenya	33,069,000
Angola	39,683,000
Madagascar	48,502,000
Belgian Congo	40,786,000
Various others	49,306,000
Total	554,386,000
Total of both groups	4,874,438,000

COFFEE IMPORTS IN 1936
PRINCIPAL CONSUMING COUNTRIES (lbs.)
(Internat. Inst. Agric.)

United States	1,730,194,000
France	411,163,000
Germany	342,379,000
Belgium	114,200,000
Sweden	102,074,000
Italy	69,887,000
Netherlands	68,344,000
Denmark	59,745,000
Argentina	50,706,000
Spain	48,702,000
Finland	48,281,000
Canada	39,683,000
Norway	35,715,000
Algeria	34,172,000
Switzerland	33,290,000
Great Britain and Northern Ireland	31,967,000
Union of South Africa	31,526,000
Czechoslovakia	24,912,000
Yugoslavia	15,212,000
Poland	13,889,000
Portugal	13,448,000
Japan	12,566,000
Austria	11,464,000
Total	3,343,319,000

IMPORTATION OF COFFEE INTO U.S.A., 1936 (bags)
(U. S. Department of Commerce)

Brazil	7,842,926	
Colombia	2,620,271	
Venezuela	459,437	
Ecuador	70,639	
Peru	411	
Chile	100	
Argentina	1,556	
Surinam	34,882	
From South America		11,030,222
Salvador	436,097	
Guatemala	418,451	
Costa Rica	59,767	
Nicaragua	56,733	
Panama	7,055	
Mexico	445,341	
Honduras	4,491	
From Central America and Mexico		1,427,935
Cuba	12,331	
Haiti	33,130	
Domin. Repub.	50,789	
Jamaica	7,695	
B. W. I.	197	
Dutch W. I.	326	
From West Indies		104,468
Arabia	28,782	
Ethiopia	10,535	
B. Ea. Afr.	164,242	
Fr. Afr. Poss.	8,538	
Port. Afr. Poss.	1,446	
Liberia	19	
From Africa and Arabia		213,562
Dutch Ea. Ind.	222,909	
Malay States	678	
From East Indies		223,587
Canada	1,786	
France	3,538	
Germany	1,296	
Holland	8,181	
U. Kingdom	50,005	
Portugal	111,865	
From non-producing countries		176,671
TOTAL		13,176,445

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In Field Museum, coffee and other caffeine yielding beverage sources, tea, cacao, maté, cola guaraná, etc., are included in the exhibit of Food Plants in Hall 25, Department of Botany.

LOADING COFFEE AT SANTOS

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